

CLAIMS

What is Claimed is:

1. A method of assembling a permanent magnet electric machine to reduce cogging torque, comprising the steps of:
 - defining a plurality of axial rotor sections on a radially outer surface of a rotor, wherein each of said axial rotor sections includes a set of permanent magnets that are in an unmagnetized state and that have opposite edges that are aligned with an axis of said rotor;
 - rotationally offsetting said axial rotor sections such that said edges of said permanent magnets define stair step interfaces; and
 - magnetizing said permanent magnets using a magnetizing fixture.
2. The method of claim 1 wherein said magnetizing fixture includes slots for receiving conductors that are skewed and wherein said conductors create substantially unmagnetized skewed areas on said permanent magnets.
3. The method of claim 2 wherein said substantially unmagnetized skewed areas are aligned with said stair step interfaces.
4. The method of claim 3 wherein said unmagnetized skewed areas have a stair step-like shape with clipping.

5. The method of claim 1 wherein said permanent magnets have a generally rectangular shape.

6. The method of claim 1 wherein a first offset angle of said axial rotor sections is approximately equal to 360 mechanical degrees divided by a least common multiple of a first number of a stator slots of said machine and a second number of rotor poles of said rotor, and divided by a third number of axial rotor sections.

7. The method of claim 1 wherein said sets of permanent magnets form m magnet poles and said magnetizing fixture includes at least m conductor slots.

8. The method of claim 6 wherein a skew angle of said magnetizing fixture is approximately equal to 360 mechanical degrees divided by the least common multiple of the first number of stator slots of said machine and the second number of rotor poles of said rotor, multiplied by a stack length of said magnetizing fixture stack, and divided by a stack length of said rotor core.

9. The method of claim 1 wherein said permanent magnets are one of arc magnets and breadloaf magnets.

10. The method of claim 7 further comprising the step of:
aligning said m conductor slots of said magnetizing fixture with said stair step
interfaces during magnetization.

11. The method of claim 10 wherein a magnetic field induced in said permanent
magnets is substantially reduced in skewed areas surrounding said stair step interfaces.

12. A permanent magnet electric machine with reduced cogging torque, comprising:
a rotor; and
a plurality of axial rotor sections defined on a radially outer surface of said rotor,

wherein each of said axial rotor sections include a set of permanent magnets,
wherein axial rotor sections are rotationally offset and said edges of said permanent magnets define stair step interfaces, and

wherein said permanent magnets of said rotor include substantially unmagnetized straight skewed areas.

13. The permanent magnet electric machine of claim 12 wherein said substantially unmagnetized straight skewed areas align with said stair step interfaces.

14. The permanent magnet electric machine of claim 13 wherein said unmagnetized skewed areas have a stair step-like shape with clipping.

15. The permanent magnet electric machine of claim 12 wherein a first offset angle of said axial rotor sections is approximately equal to 360 mechanical degrees divided by a least common multiple of a first number of a stator slots of said machine and a second number of rotor poles of said rotor, and divided by a third number of said axial rotor segments.

16. The permanent magnet electric machine of claim 12 wherein each of said sets of permanent magnets include m magnet poles and said magnetizing fixture includes at least m conductor slots.

17. The permanent magnet electric machine of claim 15 wherein a skew angle of a magnetizing fixture is approximately equal to 360 mechanical degrees divided by the least common multiple of said first number and said second number, multiplied by a stack length of said magnetizing fixture, and divided by a stack length of said rotor.

18. The permanent magnet electric machine of claim 12 wherein said permanent magnets are one of arc magnets and breadloaf magnets.

19. A method of assembling a permanent magnet electric machine to reduce cogging torque, comprising the steps of:

attaching n sets of permanent magnets that are in an unmagnetized state to a radially outer surface of a rotor, wherein said n sets of permanent magnets are positioned in n axial rotor sections and are substantially rectangular, and wherein n is greater than one;

rotationally offsetting said n axial rotor sections, wherein a first offset angle of said n axial rotor sections is approximately equal to 360 mechanical degrees divided by a least common multiple of a first number of a stator slots of said machine and a second number of rotor poles of said rotor, and divided by n ; and

magnetizing said n sets of permanent magnets using a magnetizing fixture.

20. The method of claim 19 wherein each of said n sets of permanent magnets includes m magnet poles and said magnetizing fixture includes at least m conductor slots.

21. The method of claim 19 wherein a skew angle of said magnetizing fixture is approximately equal to 360 mechanical degrees divided by the least common multiple of said first number and said second number, multiplied by a stack length of said magnetizing fixture, and divided by a stack length of said rotor.

22. The method of claim 19 wherein said permanent magnets are one of arc magnets and breadloaf magnets.

23. The method of claim 19 wherein edges of said permanent magnets define axially aligned stair step interfaces and wherein a magnetic field impressed in said permanent magnets includes substantially unmagnetized skewed areas.

24. The method of claim 23 wherein said substantially unmagnetized skewed areas align with said step interfaces.

25. The permanent magnet electric machine of claim 24 wherein said unmagnetized skewed areas have a stair step-like shape with clipping.

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26. A method of assembling a permanent magnet electric machine to reduce cogging torque, comprising the steps of:

attaching n sets of permanent magnets that are in an unmagnetized state to a radially outer surface of a rotor, wherein said n sets of permanent magnets are placed in n axial rotor sections, wherein n is greater than one, and wherein axial edges of said permanent magnets form a stair step interface; and

magnetizing said n sets of permanent magnets using a magnetizing fixture having conductor slots that are aligned with said stair step interface.

27. The method of claim 26 wherein said permanent magnets have a generally rectangular shape.

28. The method of claim wherein a first offset angle of said n axial rotor sections is approximately equal to 360 mechanical degrees divided by a least common multiple of a first number of a stator slots of said machine and a second number of rotor poles of said rotor, and divided by n .

29. The method of claim 26 wherein each of said n sets includes m permanent magnets and said magnetizing fixture includes at least m conductors.

30. A permanent magnet electric machine with reduced cogging torque, comprising:
a rotor; and
a plurality of axial rotor sections defined on a radially outer surface of said rotor,

wherein each of said axial rotor sections include a set of permanent magnets that are initially attached in an unmagnetized state and that have opposite edges that are aligned with an axis of said rotor,

wherein said permanent magnets of said rotor include at least one substantially unmagnetized stair step area and at least one straight skewed unmagnetized area.

31. The permanent magnet electric machine of claim 31 wherein said unmagnetized stair step area and said unmagnetized straight skewed area overlies one another thus forming an unmagnetized area with clipping.